Melanie Cole (host): Welcome to the podcast series from the specialists at Penn Medicine. I'm Melanie Cole. And today, we're discussing the Neurocritical Care Program at Penn Medicine. Joining me is Dr. Joshua Levine. He's the Chief in the Division of Neurocritical Care at Penn Medicine.

Dr. Levine, thank you for joining us today. Can you start by telling us a little bit about the Neurocritical Care Program at Penn Medicine? Give us a bit of an overview.

Dr. Joshua Levine: Sure. It's pleasure to talk to you today about the Penn Neurocritical Care Program, which is an internationally renowned program that really focuses on severe acute injuries to the central and peripheral nervous system. The program fulfills all three missions of a traditional academic program, in that we provide clinical care to patients, we provide education and we focus on research.

In terms of the clinical care, we provide care for patients in two dedicated neuro-intensive care units. One neuro ICU has 24 beds and is located on the 10th floor of the brand new state-of-the-art Pavilion at the Hospital of the University of Pennsylvania (HUP). And this neuro ICU is part of HUP's Comprehensive Stroke Center, so it tends to have a focus on patients with vascular diseases of the nervous system. And it's directed by Dr. Monisha Kumar, who's one of the first women ICU directors at Penn.

The other neuro ICU has 12 beds and is located on the fifth floor of the relatively new ICU tower at Penn Presbyterian Medical Center, which is a level one trauma center. So this ICU tends to have a focus on traumatic injuries to the nervous system and it's directed by Dr. John Chandler.

So the patient populations that we care for in these two ICU's are distinct, but have significant overlap. And in terms of the specific types of conditions we care for, some examples would include patients with acute ischemic and hemorrhagic strokes, including subarachnoid hemorrhage, traumatic brain injury, traumatic spinal cord injury, seizures, infections and inflammatory conditions of the nervous system like meningitis and encephalitis, brain tumors, hydrocephalus, and even acute peripheral nervous system emergencies like Guillain-Barré syndrome and myasthenia gravis.

We also take care of nervous system complications of systemic disease, for example, cardiac arrest. You know, if you survive your cardiac arrest, the major determinant of your outcome is brain health. So, we take care of patients who've

had cardiac arrest and, of course, we also take care of patients that have had complex neurosurgical procedures to help them recover postoperatively.

And providing all of this care is a multidisciplinary team, consisting of faculty that actually have very diverse backgrounds. We have faculty from neurology, internal medicine, anesthesiology, and traumatology. We also work hand in hand with advanced practice providers, bedside nurses, medical trainees of all types. And rounding with us every day are respiratory therapists, nutritionists, pharmacologists, and physical and occupational therapists. As you can see, it truly takes a village to care for any one of these patients given how complex they are.

Host: Wow. What a great program.

Dr. Joshua Levine: But the program doesn't stop there. As I mentioned, we also have an educational arm and we run one of the largest and most competitive neurocritical care fellowships in the world. And at any given time, we have 10 to 11 fellows. And our aim is to really train the next generation of leaders in our field. Dr. Atul Kalanuria runs this program and we're really proud of a relationship he's developed with the US Armed Forces. And for the past many years, the military has sent physicians to Penn every year to train in our fellowship program. We're also proud of the fact that we have an excellent track record of recruiting diverse fellows from underrepresented groups in medicine. And of course, in addition to fellows, we train residents in neurology and neurosurgery, medical students, and fellows from other disciplines.

And in terms of research, Dr. Danielle Sandsmark is the Director of Neurocritical Care Research. And we have a very robust research program with a portfolio of funding from both government and non-governmental sources. Our division does clinical research, translational research, epidemiological research and even basic science research. And by far, the largest focus is on traumatic brain injury. And I think we really have an optimal blend of clinically-focused faculty and research research-focused faculty. And that's allowed us to develop really deep expertise, both clinically and academically.

Host: Dr. Levine, as you're describing the program's highlights and features, you mentioned that it's internationally recognized. Can you talk a little bit about some of the ways that Penn goes above and beyond? Why is this program considered elite?

Dr. Joshua Levine: Yeah. You know, this is a really exciting area to me. And it starts out by explaining that neurocritical care has some important differences

from other specialties in critical care. And one of the biggest differences is that in other ICUs, for example, let's say a cardiac ICU, where the focus is on the heart, there are bedside monitors and blood tests that tell the doctors how well the heart is doing. And if you go to a general medical ICU, where the focus is on the lungs, there are monitors and blood tests that provide the same type of information about the lungs. And when people in these types of ICU's are deteriorating, it becomes very noisy. Monitors and alarms are beeping and buzzing, and it's obvious that something terrible is wrong and people rush into the room.

But with brain injury, it's very different: patients die silently. The primary way that neurologists assess function of the nervous system, let's say in an office visit, is through the physical exam of the nervous system. There are no widely used monitors or blood tests that can really tell us whether the patient is deteriorating. It's really all about the physical exam. And the problem with this is that when the brain is severely injured and the patient's in a coma, the physical exam, which is the primary tool we have for assessing brain function provides a lot less information. And so, when a patient's brain is deteriorating, they're lying in the bed quiet, not moving around. There's no alarm that's going off. There's no monitor that's beeping or buzzing and they can deteriorate or, even worse, die in complete silence. And what this means is that historically physicians who are caring for patients with severe injury were essentially flying blind, having to guess about how the patient is doing. And what's even worse is that this has led to the erroneous idea that nothing can be done to treat these conditions.

And so one of the main reasons that Penn Neurocritical Care is special is that we're working hard to change all of this. Penn is one of the pioneers in using and studying advanced technologies that together paint a very detailed picture of how the injured brain is doing. We now use all of these advanced technologies to regain our sight about brain health and especially about the impact our therapies are having. We can tell whether the patient's getting worse or better, whether they're responding to a therapy or not. So I think that's one of the reasons that the Penn program is renowned and something that makes it a little bit unique.

Host: Well, thank you for that. So I'd like you to tell us a little bit about the advanced technology available for patients and how you're using that to care for patients. You spoke earlier about Penn's ability to provide individualized care with some of these latest advances. So where do you see neurocritical care heading next? And tell us about some of the tech that might help get you there,

if you'd speak to AI just a bit and any other technology you'd like other providers to know about.

Dr. Joshua Levine: Sure. Well, you know, the ultimate goal when any ICU doctor is providing ICU care or when an ICU doctor's resuscitating a patient, and this refers to people who have heart failure or respiratory failure or kidney failure or brain failure, coma, the main goal is really to restore and maintain tissue metabolic health. And for any organ, including the brain, what this really boils down to is ensuring there's an adequate supply of fuel and, in this case, oxygen and glucose, to meet the metabolic requirements of the cells. And for the first time, we have a series of technologies that can tell us exactly that. Are the brain cells getting enough fuel to meet their metabolic demands? And many of these technologies are invasive probes that are put directly into brain tissue through a hole that's drilled in the skull.

So in terms of specifics, we have probes that tell us about how much blood flow the brain is getting. Other probes, tell us about how much oxygen the brain is getting and, equally importantly, how much oxygen the brain needs. We also have probes that give us detailed information about brain biochemistry. By measuring specific molecules from the brain itself, we can tell whether the brain cells are healthy or dying or dead. And what's truly amazing is to watch how all of these data points change.

In real time as we're delivering various therapies, we can now tell whether our therapies are working or whether the patient is improving or worsening or staying the same. We finally have some sight into the integrity of brain tissue. And I really think these technologies have the potential to revolutionize neurocritical care. When I was in training, if you had told me about some of these technologies, I would have said that's science fiction. But here we are in 2022 using these technologies routinely to provide patient care.

With all of this advanced technology comes a major challenge that we have to overcome. And that challenge is that with all of these monitors, the amount of information we receive every single second is overwhelming. And in fact, it's too much information for a physician to optimally interpret in real time. And I really think that the next step will be employing artificial intelligence to synthesize all of this data and ideally to provide bedside decision support. And given the volume of data that we're dealing with, machines are really ideally suited to this task. So it's a major challenge and to help realize this idea of using artificial intelligence, we're in the process of setting up a center for neurocritical care bioinformatics.

And this is going to be a multidisciplinary effort that involves physicians, computer scientists, and data scientists and others. And the goal is to create an artificial intelligence platform that can take all of this physiologic data coming from all of our monitors, both invasive and non-invasive maybe combine it with imaging data, data from the patient's chart and then to help us classify the pattern of data for a particular patient into a specific physiologic state. And that then will inform what the most appropriate therapy is. So this is really the ultimate realization of individualizing care for the particular patient in the bed in front of us.

And it's a little ways off right now but the technologies for patient care are certainly here and we're certainly using them and studying them. I think the next step is harnessing the power of machine learning and artificial intelligence to help us utilize these data better.

Host: Thank you so much, Dr. Levine, for joining us today and sharing your incredible expertise and telling us about the Neurocritical Care Program at Penn Medicine. To refer your patient to Dr. Levine at Penn Medicine, please call our 24/7 provider only line at 877-937-PENN. Or you can submit your referral via our secure online referral form by visiting our website at pennmedicine.org/referyourpatient.

That concludes this episode from the specialists at Penn Medicine. Please remember to subscribe, rate and review this podcast and all the other Penn Medicine podcasts. And for the latest updates on the medical advancements, breakthroughs and research, please follow us on your social channels. I'm Melanie Cole.